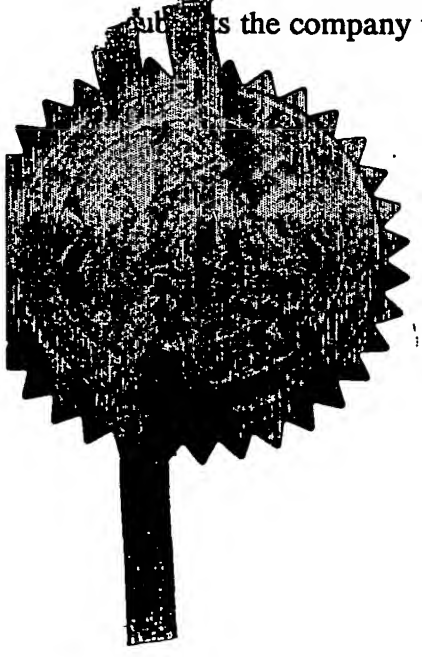
The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.



PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Signed

Dated 12 November 2003

Patents Form 1/77

Patents Act 1977
(Rule 16)

THE PATENT OFFICE
D
- 9 JAN 2003
NEWPORT

The Patent Office

09JAN03 E775661-2 002835
P01/7700 0.00-0300434.8
The Patent Office

Cardiff Road
Newport
South Wales
NP9 1RH

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference — SHG/P501127

2. Patent application number *(The Patent Office will fill in this part)* — 0300434.8 — 9 JAN 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)* — University College Cardiff Consultants Ltd

PO Box 497
56 Park Place
Cardiff
CF10 3XR

Patents ADP number *(if you know it)* 8[illegible]

If the applicant is a corporate body, give the country/state of its incorporation — UK 1986030 09.

4. Title of the invention — Semiconductor Optical Devices

5. Name of your agent *(if you have one)* — URQUHART-DYKES & LORD

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Three Trinity Court
21-27 Newport Road
CARDIFF
CF24 0AA

Patents ADP number *(if you know it)* — 1644025

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	3
Claim(s)	
Abstract	1
Drawing(s)	1

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature URQUHART-DYKES & LORD Date 08.01.03

12. Name and daytime telephone number of person to contact in the United Kingdom: Stewart Gibson 029 2048 7993

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

e) *Once you have filled in the form you must remember to sign and date it.*

f) *For details of the fee and ways to pay please contact the Patent Office.*

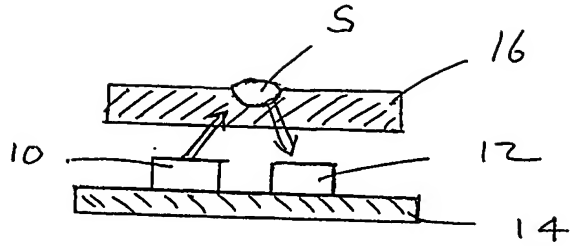


Figure 1

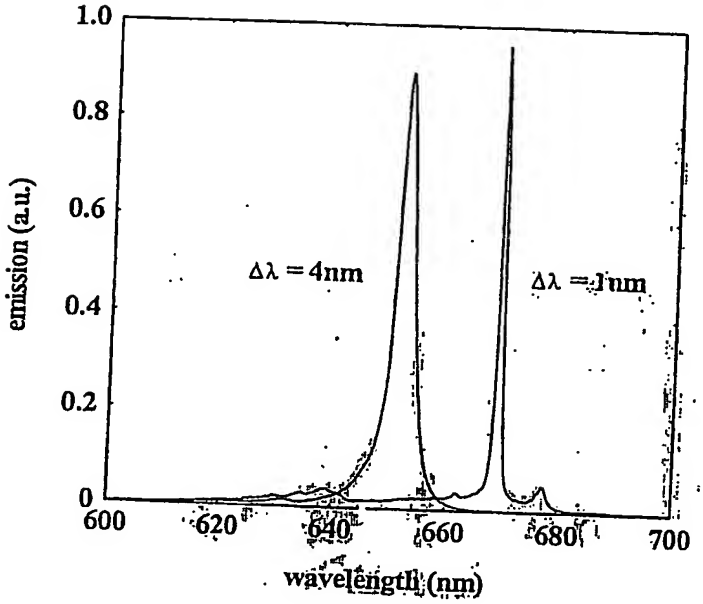


Figure 2

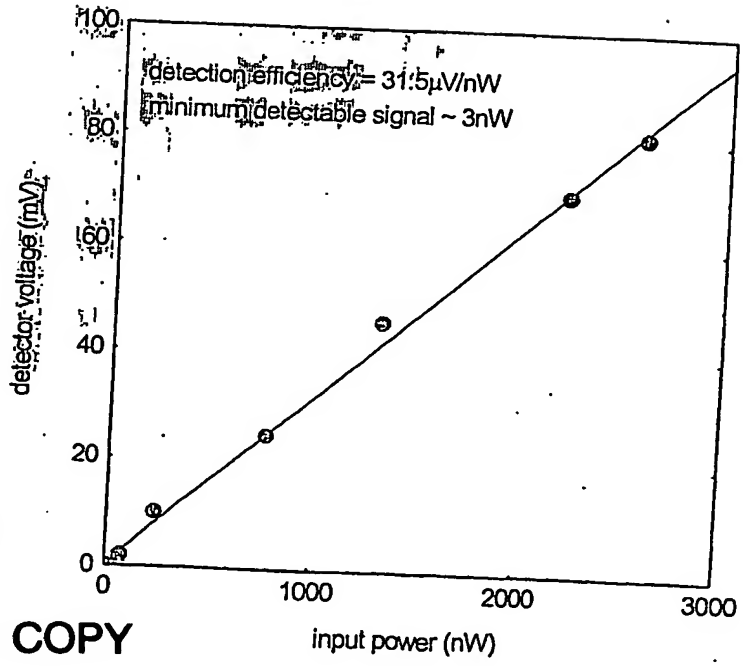


Figure 3

Semiconductor Optical Devices

The present invention relates to semiconductor optical devices, particularly but not solely for use in the field of bio-chemical or bio-medical analysis.

The use of optical techniques for the analysis of biological samples is a field of increasing importance, particularly in view of its potential for analysis at a molecular level. Various optical systems have been proposed hitherto: these systems have generally made use of a laser or other light emitter for directing light onto successive samples in an array, and a separate detector for picking up light from the individual samples; typically the samples have been marked with a flourescent dye, such that the incident light stimulates each sample to cause the emission of light of a different wavelength, which is picked up by the photodetector. Hitherto, such systems have been of large and complicated construction, for laboratory use. We have now devised a device of simple and small construction, which enables the device to be used in the field.

In accordance with the present invention, there is provided a device for the analysis or testing of a biological sample, the device comprising a single light emitter for directing light onto a sample, and a single photodetector for receiving light from the sample.

The device is accordingly a single-channel device for use with a single sample (or a single sample at a time). The device may be constructed to a very small size and inexpensively, so that it can be used with ease in the field, and may indeed comprise a single use or disposable device.

The light emitter and photodetector may be mounted side-by-side and arranged for the biological sample to be positioned over them. The device may comprise a carrier substrate for the sample, positioned permanently or removably over the light emitter and photodetector.

Preferably the light emitter has a light emission peak at one wavelength and the photodetector has a light-absorbing peak at a different wavelength. In particular, the device may be arranged to detect fluorescent emission from the sample, stimulated by the light incident on it from the emitter.

The light emitter may comprise a vertical-cavity, surface emitting laser (VCSEL) or a resonant-cavity, light emitting diode (RCLED). The photodetector may comprise an identical device, having its emission peak at a different (longer) wavelength and used with a reverse bias, so as to act as a photodetector.

An embodiment of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which;

FIGURE 1 is a schematic cross-section through a device in accordance with the invention;

FIGURE 2 is a graph showing the emission spectra of two light emitters used in the device of Figure 1; and

FIGURE 3 is a plot showing the detection performance of one of the light emitters, used with reverse bias to act as a photodetector.

Referring to Figure 1 of the drawings, there is shown a device for the analysis of a biological sample, the device comprising a semiconductor light emitter 10 and a semiconductor photodetector 12 mounted side-by-side on a substrate 14. A sample-carrier 16 is positioned over the light emitter 10 and photodetector 12 and comprises a transparent substrate the upper surface of which is formed with a recess or well to receive the sample S to be analysed or tested. The substrate 16 may form a permanent part of the device, or it may be removable and replaceable.

The device is arranged so that the light emitted by the emitter 10 is incident on the sample S and the photodetector 12 picks up light returned from the sample S. In the example shown in Figure 1, the light emitter 10 comprises a resonant-

cavity, light emitting diode (RCLED) with an emission peak at a wavelength of 650nm: the photodetector comprises an identical device except that it has an emission peak at 670nm and is used with a reverse voltage bias (so as to act as a photodetector rather than light emitter). In use of the device, the sample S is marked with a fluorescent dye: accordingly, the light of 650nm wavelength which is incident on the sample, from the emitter 10, stimulates the sample to cause emission of light of the longer-wavelength, which is piked up by the photodetector 12.

We have made and tested light emitters and photodetectors in the form of GaInP crystals having multiple-layer Bragg reflectors to produce circular beams perpendicular to their surfaces. By control of the thickness of these crystals, we formed two devices with emission peaks at 650nm and 670nm, respectively: the first such device is used as the emitter 10 and the second device, under reverse bias, as the photodetector 12.

Figure 2 shows the emission spectra of the two devices, one having a peak at 650nm and the other a peak at 670nm.

Figure 3 shows the detected photovoltage, of the photodetector 12, in response to an optical signal. We found detection possible down to a noise floor of 3nW: for a typical fluorescent dye with a radiative lifetime of 5ns, this corresponds to the detection of the fluorescent emission from just 51 molecules, demonstrating the extremely high sensitivity of the photodetector.

It will be appreciated that the device described with reference to Figure 1 also comprises a battery power source for applying forward and reverse voltages to the emitter 10 and photodetector 12, respectively: the device further comprises a circuit for measuring the voltage or current output of the photodetector.